International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD)
ISSN(P): 2249-6866; ISSN(E): 2249-7978
Vol. 3, Issue 5, Dec 2013, 91-98

OPTIMUM REPLACEMENT OF NATURAL SAND WITH ARTIFICIAL SAND IN CONCRETE

RAJENDRA P. MOGRE[1] & DHANANJAY K. PARBAT[2]

[1]Principal, Government Polytechnic Yavatmal, Maharashtra, India

[2]Lecturer in Civil Engineering, Government Polytechnic, Sakoli, Maharashtra, India

ABSTRACT

This paper Present the experimental study of optimum replacement of natural sand with artificial sand in concrete Concrete is a mix proportion of cement, sand and aggregate. The strength of aggregate will affect on the strength of concrete. Nowadays we are facing a problem due to scarcity of natural sand. Hence it is necessary to find suitable substitute for natural sand. The artificial sand is one of the suitable substitutes to natural sand. Artificial sand is produced from quires stone crusher. Which is specially prepared so as to get smooth textured, well graded particles. Artificial sand is cheap and easily available in local areas. For the purpose of experimentation concrete mixes are design for M20, M25, M30, M35 and M40 grades by 0 to 100 % replacement with increment of 20 % and in critical zone the increment is of 5% for Compressive, tensile and flexural strength.

KEYWORDS: Natural Sand, Artificial Sand, Concrete Mix, Compressive Strength, Split Tensile Strength, Flexural Strength

INTRODUCTION

We cannot imagine Civil Engineering structures without concrete. Concrete is backbone of infrastructural development of whole world. Concrete has capacity to enhance its properties with the help of other suitable material. Maximum volume of concrete is made of aggregate.

The aggregate characteristics are influence the workability bleeding and segregation and durability of concrete. Fine aggregates may be Natural sand, crushing natural gravels, crushing hard stones (artificial sand).

Since from last twenty years we find that the availability of good quality of natural sand is decreasing. The natural sand deposits are drying up and hence there is an acute need to find suitable substitute that matches the properties of natural sand. The natural sand deposits are being emptied by construction industries.

The quarry stone crushers are situated in the nearby areas from which it is possible to get artificial sand. By using artificial sand we can overcome environmental problems and protect river bed against erosion also remain as filter for ground water. Thus for preserving areas of beauty, recreational values and biodiversity most of local government agencies granting permissions to aggregate producers across the world. These are the facts in construction industry today and definitely it will not change dramatically. The rigorous study is necessary for use of artificial sand in place of natural sand. In this paper the comparable test results of compression, flexural and split tensile strength of concrete by replacing natural sand 0% , 20%, 40%, 60% 65% 70% 75% 80% and 100% by artificial sand for M20 M25 M30 M35 M40 grades of concrete are presented.

LITERATURE REVIEW

Sahu A. K, in January 2003 study shows that There is increase in compressive strength modulus of rupture and split strength by replacing natural sand with stone pressure west with 20 and 40 percent as fine aggregate.

M. R. Chitlange in 2010 study shows that mixes with artificial sand as fine aggregate gives consistently higher strength than the mixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with cement than the rounded particles of natural sand resulting in higher strength. The excessive bleeding of concrete is reduced by using artificial sand.

R. Ilangovana1, N. Mahendrana1 and K. Nagamanib2 states that the Physical and chemical properties of quarry rock dust is satisfied the requirements of code provision in properties studies. Natural river sand, if replaced by hundred percent Quarry Rock Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, in terms of compressive and flexural strength studies

Priyanka A. Jadhava and Dilip K. Kulkarni study shows the effect of partial replacement of natural sand by manufactured sand on the compressive strength of cement mortar of proportion 1:2, 1:3 and 1:6 with water cement ration as 0.5 and 0.55 are studied. Results are compared with reference mix of 0% replacement of natural sand by manufactured sand. The compressive strength of cement mortar with 50% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix. The overall strength of mortar linearly increases for 0%, 50% replacement of natural sand by manufactured sand as compared with reference mix (Mix 1). Manufactured sand has a potential to provide alternative to natural sand and helps in maintaining the environment as well as economical balance.

Vinayak R. Supekar, Popat D. Kumbhar's study shows the replacement of natural sand by 60% artificial sand results in producing the concrete of satisfactory workability and strength properties. It is also possible to minimize the area of surface cracks of concrete, thus achieving the durable concrete. However, for more than 60% replacement of natural sand by artificial sand causes reduction in compressive strength of concrete mixes with increase in the area of cracks. The replacement of natural sand with artificial sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

Kode V. R. Reported that concrete with stone dust as a fine aggregate yielded 10 % higher compressive strength 24% higher Tensile strength 26% higher Flexural strength over the concrete with natural sand.

Prakash Rao D.S. and Giridhar kumar V. investigated the concrete with stone crusher dust which is available abundantly from crusher unit at low cost, the test conducted pertain to concrete with reverse sand of strength 28.1 mpa and that with granite stone crusher dust of strength 32.8 mpa. Test on strength of concrete and on flexural behaviour of RC beam under 2 point loading sustained about 6 percent more load.

Rajendra P. Mogre , Dr. Dhananjay K. Parbat & Dr. Sudhir P. Bajad study shows there is feasibility of artificial sand in concrete. The replacement of natural sand by artificial sand is feasible for 60% to 80%.

It is seen from above studies there is a variation in strength enhancement of concrete made from artificial sand to encourage the use of locally available artificial sand promotes to study to check it suitable optimum percentage replacement in the concrete.

MATERIAL

CEMENT

Ordinary Portland cement of 53 grades confirming to IS 12269-1987 was used. The physical properties are tabulated as shown below (Table-1)

Table 1: Physical Properties of Cement (53 Grade)

No.	Property	Value
1	Specific gravity	3.12
2	Soundness	1.20 mm
3	Initial setting time	167 minute
4	Final setting time	255 minute
5	Normal Consistency	31%
6	Fineness m3/ Kg	320
7	28 days compressive strength	58.25 MPa

Fine Aggregate

Natural sand obtained from the river and available in the local market was used. The artificial sand obtained from the local crusher was used. The physical properties of natural and artificial sand are as below.

Table 2: Properties of Natural and Artificial Sand

Property	Natural Sand	Artificial
Specific Gravity	2.6	2.90
Fineness Modulus	2.78	2.97
Bulk Density kn/m3	15.60	17.62

Table 3: Sieve Analysis Details of Natural and Artificial Sand

IS Sieve	Percentage Passing	
	Natural Sand	Artificial Sand
4.75 mm	96.2	95
2.36 mm	88.4	79
1.18 mm	65.8	55
600 micron	47.1	41
300 micron	19.6	20
150 micron	5	13

Coarse Aggregate

Locally available rock stone aggregate of nominal size 10 mm and 20 mm mixed aggregate are used. The physical properties of these coarse aggregates are as below (Table-4 & 5).

Table 4: Properties of Coarse Aggregate

No.	Property	Value
1	Specific Gravity	2.96
2	Bulk density kn/m3	16.10
3	Fineness Modules (20 and 10) mm	7.35

Table 5: Sieve Analysis of Coarse Aggregate

IS Sieve	Percentage Passing
40 mm	100
20 mm	85
10 mm	18
4.75 mm	1.87

Table 6: Quantity of Material (For Mix)

Sr. No	Grade of Concrete	M 20	M 25	M 30	M 35	M 40
1	Cement kg/m3	315	350	380	420	445
2	Fine aggregate kg/m3	615	600	592	570	560
3	Coarse Aggregate(10 mm and 20 mm) kg/m3	1300	1261	1259	1250	1200
4	Aggregate cement ratio	6.07	5.31	4.87	4.33	3.95
5	Water litter /m3	156	162	175	182	180
6	Water cement ratio	0.49	0.46	0.46	0.43	0.41

EXPERIMENTATION

The physical Characteristics of material used that is cement natural sand, artificial sand and course aggregate are tested initially.

The exact amount of concrete ingredients (Table-6) were weighed and mixed thoroughly by using super plasticiser in laboratory concrete mixer till the consistent mix was achieved. The workability of fresh concrete was measured. The standard cube of 150 mm size steel mould and cylinder of 150 mm. diameter and 300 mm. length and prism of size 100 X 100 X 500 were tested over a span of 400 mm. compacted on vibrating table. Six cubes, six cylinders and six prism with varying percentage of natural and artificial sand were casted for testing. The average strength was calculated as per acceptance criteria using IS 456 – 2000 is followed and the average values are illustrated in tables (Table-7).

CONCLUSIONS

The conclusions based on the experimental result are as below.

- It is observed that optimum replacement of natural sand by artificial sand is 65 %.
- There is consistent increase in strength of concrete by replacing natural sand with artificial sand up to 65%.
- For optimum replacement 65% artificial sand & 35% natural sand the % increase in compressive, Flexural & split tensile are as below.
- It is observed that the percentage increase in strength is maximum for M20 grade and gradually reducing For M40 grade.
- It can be seen that the sharp ages of particle in artificial sand provide better bond is cement than natural sand.
- The cost of artificial sand is less that of natural sand. Hence artificial sand can be recommended to competitive substitute for natural sand.

Table 7

Grade of Concrete	Compressive Strength	Flexural Strength	Split Tensile Strength
M20	10.40	14.20	11.15
M25	09.50	12.90	10.60
M30	08.90	11.80	10.20
M35	08.40	10.90	10.12
M40	08.10	11.40	09.70

Table 8: Compressive Strength, Flexural Strength and Split Tesile Stregth with Different Replacement Percentage

Sr. No	Artificial Sand (%)	Natural Sand (%)	Concrete Grade	Average Compressive. Strength N/mm2		Average Flexural Strength N/mm2		Average Split Tensile Strength N/mm2	
				7 Day	28 Day	7 Day	28 Day	7 Day	28 Day
1	00	100	M20	19.80	27.50	2.25	3.30	1.82	2.60
			M 25	23.30	33.30	2.61	3.70	2.50	3.30
			M 30	27.37	39.10	3.20	4.90	2.85	3.80
			M 35	29.12	42.20	3.60	5.30	3.01	3.95
			M 40	32.80	49.10	4.02	5.75	3.30	4.60
2	20	80	M 20	20.30	28.09	2.35	3.35	1.91	2.74
			M 25	24.44	35.13	2.85	4.02	2.70	3.57
			M 30	28.60	41.05	3.48	5.30	3.01	4.03
			M 35	30.37	44.27	3.88	5.69	3.17	4.26
			M 40	34.11	51.46	4.33	6.15	3.50	4.95
3	40	60	M 20	20.59	28.82	2.42	3.53	1.98	2.80
			M 25	24.97	35.93	2.87	4.02	2.71	3.58
			M 30	29.28	41.84	3.54	5.43	3.08	4.11
			M 35	31.13	45.03	3.97	5.83	3.25	4.26
			M 40	35.03	52.29	4.42	6.30	3.54	4.96
4	60	40	M 20	21.48	30.03	2.50	3.63	1.99	2.85
			M 25	25.11	36.36	2.88	4.11	2.74	3.63
			M 30	29.55	42.37	3.52	5.45	3.01	4.19
			M 35	31.45	45.79	3.94	5.86	3.27	4.33
			M 40	35.39	53.00	4.38	6.32	3.58	5.02
5	65	35	M 20	21.74	30.38	2.56	3.77	2.02	2.89
			M 25	25.44	36.49	2.93	4.18	2.76	3.65
			M 30	29.69	42.58	3.57	5.48	3.13	4.19
			M 35	31.19	45.78	3.97	5.88	3.29	4.35
			M 40	35.43	53.10	4.43	6.41	3.60	5.05
6	70	30	M 20	21.56	30.25	2.54	3.72	1.95	2.80
			M 25	25.25	36.29	2.85	4.10	2.67	3.60
			M 30	29.58	42.50	3.50	5.43	3.04	4.06
			M 35	31.54	45.51	3.93	5.84	3.21	4.22
			M 40	35.03	52.78	4.38	6.30	3.49	4.87
7	75	25	M 20	20.80	29.90	2.48	3.65	1.90	2.76
			M 25	24.70	35.80	2.75	4.00	2.61	3.50
			M 30	29.10	42.00	3.40	5.35	3.01	3.95
			M 35	31.00	44.20	3.85	5.80	3.15	4.15
			M 40	34.80	51.20	4.25	5.05	3.45	4.80
8	80	20	M 20	20.20	28.70	2.35	3.50	1.80	2.68
			M 25	23.90	34.30	2.68	3.85	2.55	3.40
			M 30	28.50	41.30	3.51	5.05	2.90	3.85
			M 35	30.30	43.20	3.72	5.55	3.10	4.05
			M 40	33.50	50.01	4.10	5.90	3.35	4.75
9	100	00	M 20	19.70	27.40	2.25	3.28	1.85	2.58
			M 25	23.25	33.10	2.60	3.65	2.45	3.20
			M 30	27.30	39.00	3.10	4.85	2.80	3.80
			M 35	29.10	41.80	3.60	5.25	3.00	3.92
			M 40	31.92	48.90	4.01	5.71	3.25	4.58

BAR CHART FOR COMPRESSIVE, FLEXURAL AND SPLIT TENSILE STRENGTH FOR 7 DAYS & 28 DAYS

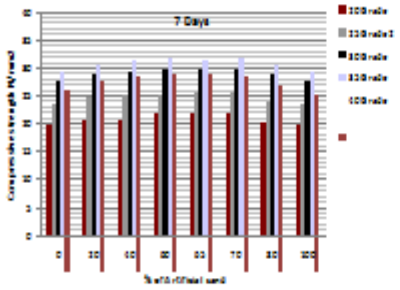

Figure 1: Bar Chart for 7 Days Compressive Strength

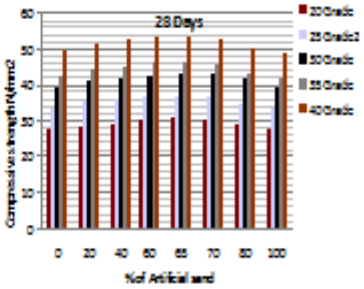

Figure 2: Bar Chart for 28 Days Compressive Strength

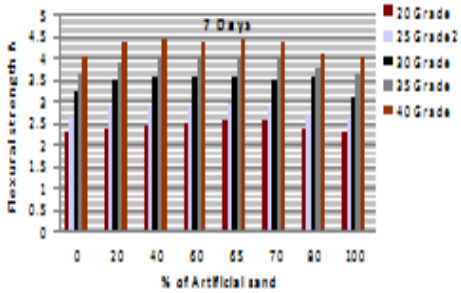

Figure 3: Bar Chart for 7 Days Flexural Strength

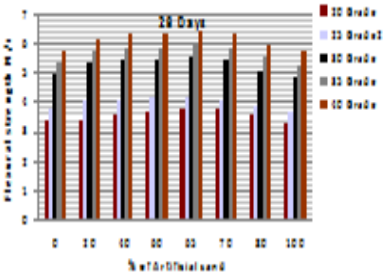

Figure 4: Bar Chart for 28 Days Flexural Strength

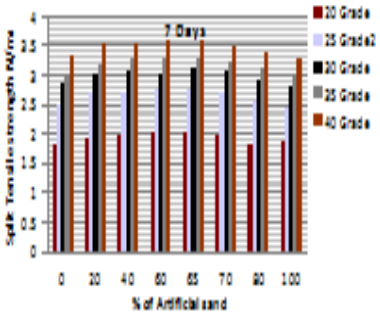

Figure 5: Bar Chart for 7 Days Split Tensile Strength

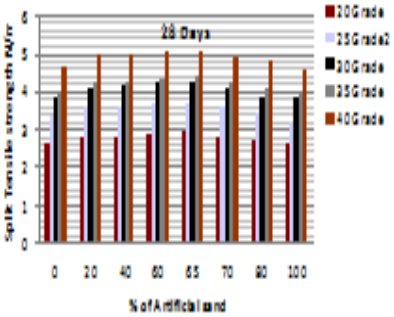

Figure 6: Bar Chart for 28 Days Split Tensile Strength

REFERENCES

1. A K Sahu, S Kumar and A K Sachin.,2003 Crushed Stone Waste as Fine Aggregate for Concrete.The Indian Concrete Journal, vol 77, no 1, p 845.
2. M R Chitlange, 2010, Appraisal of Artificial Sand Concrete, IE(I) Journal Volume 90.
3. R. Ilangovana1, N. Mahendrana1 and K. Nagamanib2, 2008, Strength And Durability Properties Of Concrete Containing Quarry Rock Dust As Fine Aggregate, ARPN Journal of Engineering and Applied Sciences, vol. 3, no. 5.
4. R Ilangovan, K Nagamani and P Gopal Swamy, 2007, Recycling of Quarry Waste as an Alternative Material in Concrete Manufacturing, Indian Construction, vol 40, no 2, p 7.
5. Ilangovan R. and Nagamani K., 2006. Application of quarry Rock dust as fine aggregate in concrete construction. National Journal on construction Management: NICMR. Pune. December. pp. 5-13.

6. Priyanka A. Jadhav, Dilip K. Kulkarni, fect of replacement of natural sand by manufactured sand on the properties of cement mortar , INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING Volume 3, No 3, 2013
7. Vinayak R.Supekar, Popat D.Kumbhar Properties Of Concrete By Replacement Of Natural Sand With Artificial Sand International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 7, September – 2012.
8. Kode V. R., Murty D.S.R., Swarna Kumar P., " Appraisal of Crushed Stone Dust, as Fine Aggregate in Structural Concrete", Civil engineering & Construction Review, Vol.20, No. 7, july 2007, pp. 52-58.
9. Prakash Rao D.S. and Gridhar V, 2004. Investigation on Concrete with Stone crusher dust as Fine aggregate. The Indian concrete Journal, pp. 45-50.
10. Rajendra P. Mogre, Dr.Dhananjay K. Parbat, Dr. Sudhir P. Bajad, feasibility of artificial Sand in concrete, International Journal of engineering research & technology (IJERT), Vol.2 Issue 7 july 2013 pp. 1606-1610.
11. Rajendra P. Mogre, Dr.Dhananjay K. Parbat, Behaviour of Polypropylene fibre reinforced Concrete with artificial sand, International refereed journal of Engineering and science, Vol.1 Issue -2, 2012, pp. 37-40.
12. Rajendra P. Mogre, Dr.Dhananjay K. Parbat, State of the art on Behavior of Polypropylene fibre reinforced Concrete with artificial sand, international conference "IC-BEST 2012" during Sept. 7-8, 2012.
13. M.S.Shetty, Concrete Technology- Theory and Practice, (Fifth revised edition, 2002, S.Chand & Company limited, New Delhi).
14. Code of Practice for Plain & Reinforced Concrete IS 456: 2000, Bureau of Indian Standards, New Delhi.
15. Recommended Guidelines for concrete mix Design, IS 10262: 1982, Bureau of Indian Standards, New Delhi.\
16. Specification for 53 Grade ordinary Portland cement, Is 12269: 1987, Bureau of Indian Standards, New Delhi.
17. Gambhir M. L., "Concrete technology", second edition, Tata McGraw-Hill Publishing Co.Ltd., new Delhi, 1998.